CLAIMS

What is claimed is:

1. A method of measuring parameters relating to a lithography device, the method comprising the steps of:

providing a substrate comprising a plurality of fields, each field having been exposed at a different focus value and comprising a plurality of diffraction structures formed on the substrate by a lithographic process utilizing the lithography device;

measuring a diffraction signature for each of a plurality of the diffraction structures in a plurality of fields by means of a radiation source-based tool;

determining for each field the variability of measured diffraction signatures obtained from the plurality of diffraction structures located within that field; and

comparing the variabilities associated with the fields to determine a desired parameter of the lithography device.

2. The method of claim 1, wherein the diffraction structures are single period, bi-periodic, multi-periodic, or non-periodic structures.

3. The method of claim 2, wherein the diffraction structures comprise gratings.

4. The method of claim 1 wherein the substrate comprises a semiconductor wafer.

5. The method of claim 1, wherein the radiation source-based tool comprises a light source-based tool.

6. The method of claim 5, wherein the light source-based tool comprises an incident laser beam source, an optical system focusing the laser beam and scanning through some range of incident angles, and a detector for detecting the resulting diffraction signature over the resulting measurement angles.

7. The method of claim 6, wherein the light source-based tool comprises an angle-resolved scatterometer.

8. The method of claim 5, wherein the light source-based tool comprises a plurality of laser beam sources.

9. The method of claim 5, wherein the light source-based tool comprises an incident broad spectral light source, an optical system focusing the light and illuminating through some range of incident wavelengths, and a detector for detecting the resulting diffraction signature over the resulting measurement wavelengths.

10. The method of claim 5, wherein the light source-based tool comprises an incident light source, components for varying the amplitude and phase of the S and P polarizations, an optical system focusing the light and illuminating over some range of incident phases, and a detector for detecting the phase of the resulting diffraction signature.

11. The method of claim 1, wherein measuring a diffraction signature comprises phase measurement by means of a broad spectral radiation source-based tool source, operating at a fixed angle, a variable angle of incidence Θ or a variable angle of sweep Φ.

12. The method of claim 1, wherein measuring a diffraction signature comprises phase measurement by means of a single wavelength radiation source-based tool source, operating at a fixed angle, a variable angle of incidence Θ or a variable angle of sweep Φ.

13. The method of claim 1, wherein measuring a diffraction signature comprises phase measurement by means of a multiple discrete wavelength radiation source-based tool source.

14. The method of claim 1, wherein the diffraction signature is a reflective diffraction signature.

15. The method of claim 1, wherein the diffraction signature is a transmissive diffraction signature.

16. The method of claim 1, wherein the diffraction signature is a specular order diffraction signature.

17. The method of claim 1, wherein the diffraction signature is a higher order diffraction signature.

18. The method of claim 1, wherein the diffraction signature is a measurement of general light scatter or diffraction.

19. The method of claim 1, wherein the desired parameter is center of focus.

20. The method of claim 1, wherein the desired parameter is dose.

21. The method of claim 1, wherein a value of the desired parameter of the lithography device is determined by a value of the desired parameter associated with the field having a minimum variability of the diffraction signatures.

22. The method of claim 1, wherein the determining step comprises measuring for each field the range of intensities of the diffraction signatures obtained from the plurality of measured diffraction structures located within that field.

23. The method of claim 1, wherein the determining step comprises calculating a statistical measure of the variability.

24. The method of claims 23, wherein the statistical measure is a root mean square error of the diffraction signatures.

25. The method of claim 1, the method further comprising forming the plurality of diffraction structures at known different focus settings and known different dose settings and determining the effect of dose on focus.

26. The method of claim 25, wherein the plurality of diffraction structures comprise sets of the same known different focus setting diffraction structures, the sets varying by different known dose settings.

27. The method of claim 1, wherein the determining step comprises

providing a library of theoretical diffraction signatures generated from theoretical diffraction structures;

determining in the library a best match theoretical diffraction signature for each measured diffraction signature;

associating a chosen feature of the best match theoretical diffraction signature with the measured diffraction signature; and

determining for each field the variability of the chosen feature associated with the plurality of diffraction structures located within that field.

28. The method of claim 27, wherein the chosen feature is critical dimension (CD).

29. The method of claim 27, wherein the chosen feature is a cross-section area.

30. The method of claim 27, wherein the chosen feature is a cross-section volume.

31. The method of claim 27, wherein the chosen feature is a product of two or more features of the theoretical diffraction structure providing the matching theoretical diffraction signature.

32. The method of claim 27, wherein the determining step comprises measuring for each field the range of the chosen features associated with the plurality of measured diffraction structures located within that field.

33. The method of claim 27, wherein the determining step comprises calculating a statistical measure of the variability.

34. The method of claim 33, wherein the statistical measure is a standard deviation of the chosen features.

35. The method of claim 1, wherein the diffraction structures comprise latent image diffraction structures.

36. The method of claim 1, wherein the substrate has not been subjected to a development process.

37. A method of process control for center of focus in a lithography device, the method comprising the steps of:

determining the center of focus of the lithography device according to the method of claim 19; and

adjusting the focus setting of the lithography device to the determined center of focus.

38. The method of claim 37, wherein the adjusting step comprises utilizing a computer-based control system.

39. The method of claim 37, wherein the adjusting step comprises an autofocus control system, wherein at least one input to the autofocus control system comprises a measure relating to a minimum variability.

40. The method of claim 37, wherein the adjusting step comprises measuring over time the variability of measured diffraction signatures obtained from the plurality of diffraction structures located within a selected field.

41. The method of claim 40, wherein the selected field was previously determined to be at the center of focus.

42. The method of claim 40, wherein the focus of the lithography device is adjusted if the variability exceeds a predetermined control limit.

43. A method of process control in a lithography device, the method comprising the steps of:

exposing a plurality of diffraction structures in a field on a series of wafers with the lithography device;

measuring a diffraction signature for each of the plurality of diffraction structures in the field on the series of wafers by means of a radiation source-based tool;

determining for each wafer the variability of measured diffraction signatures obtained from the plurality of diffraction structures; and

comparing the variabilities associated with the wafers to control a desired parameter of the lithography device.

44. The method of claim 43, further comprising the step of adjusting at least one desired parameter of the lithography device in response to the compared variabilities associated with the wafers.

45. The method of claim 44, wherein the adjusting step comprises comparing the variabilities to an empirically determined variability limit.

46. The method of claim 44, wherein the adjusting step comprises comparing the variabilities to a theoretically determined variability limit.

47. The method of claim 44, wherein the at least one desired parameter comprises focus or dose.

48. The method of claim 43, wherein the diffraction structures are single period, bi-periodic, multi-periodic, or non-periodic structures.

49. The method of claim 48, wherein the diffraction structures comprise gratings.

50. The method of claim 43 wherein the wafers comprise semiconductor wafers.

51. The method of claim 43, wherein the radiation source-based tool comprises a light source-based tool.

52. The method of claim 51, wherein the light source-based tool comprises an incident laser beam source, an optical system focusing the laser beam and scanning through some range of incident angles, and a detector for detecting the resulting diffraction signature over the resulting measurement angles.

53. The method of claim 52, wherein the light source-based tool comprises an angle-resolved scatterometer.

54. The method of claim 51, wherein the light source-based tool comprises a plurality of laser beam sources.

55. The method of claim 51, wherein the light source-based tool comprises an incident broad spectral light source, an optical system focusing the light and illuminating through some range of incident

wavelengths, and a detector for detecting the resulting diffraction signature over the resulting measurement wavelengths.

56. The method of claim 51, wherein the light source-based tool comprises an incident light source, components for varying the amplitude and phase of the S and P polarizations, an optical system focusing the light and illuminating over some range of incident phases, and a detector for detecting the phase of the resulting diffraction signature.

57. The method of claim 43, wherein measuring a diffraction signature comprises phase measurement by means of a broad spectral radiation source-based tool source, operating at a fixed angle, a variable angle of incidence Θ or a variable angle of sweep Φ.

58. The method of claim 43, wherein measuring a diffraction signature comprises phase measurement by means of a single wavelength radiation source-based tool source, operating at a fixed angle, a variable angle of incidence Θ or a variable angle of sweep Φ.

59. The method of claim 43, wherein measuring a diffraction signature comprises phase measurement by means of a multiple discrete wavelength radiation source-based tool source.

60. The method of claim 43, wherein the diffraction signature is a reflective diffraction signature.

61. The method of claim 43, wherein the diffraction signature is a transmissive diffraction signature.

62. The method of claim 43, wherein the diffraction signature is a specular order diffraction signature.

63. The method of claim 43, wherein the diffraction signature is a higher order diffraction signature.

64. The method of claim 43, wherein the diffraction signature is a measurement of general light scatter or diffraction.

65. The method of claim 43, wherein the determining step comprises measuring for each wafer the range of intensities of the diffraction signatures obtained from the plurality of measured diffraction structures located within the field on that wafer.

66. The method of claim 43, wherein the determining step comprises calculating a statistical measure of the variability.

67. The method of claim 66, wherein the statistical measure is a root mean square error of the diffraction signatures.

68. The method of claim 43, wherein the determining step comprises

providing a library of theoretical diffraction signatures generated from theoretical diffraction structures;

determining in the library a best match theoretical diffraction signature for each measured diffraction signature;

associating a chosen feature of the best match theoretical diffraction signature with the measured diffraction signature; and

determining for each wafer the variability of the chosen feature associated with the plurality of diffraction structures located within the field on that wafer.

69. The method of claim 68, wherein the chosen feature is critical dimension (CD).

70. The method of claim 68, wherein the chosen feature is a cross-section area.

71. The method of claim 68, wherein the chosen feature is a cross-section volume.

72. The method of claim 68, wherein the chosen feature is a product of two or more features of the theoretical diffraction structure providing the matching theoretical diffraction signature.

73. The method of claim 68, wherein the determining step comprises measuring for each wafer the range of the chosen features associated with the plurality of measured diffraction structures located within the field on that wafer.

74. The method of claim 68, wherein the determining step comprises calculating a statistical measure of the variability.

75. The method of claim 74, wherein the statistical measure is a standard deviation of the chosen features.

76. The method of claim 43, wherein the diffraction structures comprise latent image diffraction structures.

77. The method of claim 43, wherein the wafer has not been subjected to a development process.